Claims

We claim:

1. An isolation barrier for conveying an electrical signal from a transmitting circuit to a receiving circuit while electrically isolating the transmitting circuit from the receiving circuit, comprising:

an isolation capacitor;

a synchronous analog-to-digital converter having an input connected to the transmitting circuit for receiving the electrical signal to be transmitted across the barrier, and an output connected to a first side of the isolation capacitor for providing a synchronous digital signal to the isolation capacitor;

a synchronous digital-to-analog converter having an input connected to a second side of the isolation capacitor for receiving the synchronous digital signal therefrom, and having an output connected to the receiving circuit for providing an analog signal thereto.

2. The isolation barrier of claim 1, wherein the barrier comprises a pair of isolation capacitors, and wherein the synchronous digital signal is a differential signal.

3. The isolation barrier of claim 1, further comprising a power supply having an input connected to the second side of the isolation capacitor to receive the synchronous digital signal therefrom, the power supply comprising a rectifier circuit for providing a DC voltage derived from energy contained in the synchronous digital signal.

4. A telephone set comprising the isolation barrier of claim 1.

5. A modem comprising the isolation barrier of claim 1.

6. The isolation barrier of claim 1, wherein the synchronous analog-to-digital converter comprises a delta-sigma modulator and wherein the synchronous digital-to-analog converter comprises a delta-sigma modulator.

7. An isolation barrier for conveying an analog data signal from a transmitting circuit to a receiving circuit while electrically isolating the transmitting circuit from the receiving circuit, comprising:

a) an analog-to-digital converter having an input connected to receive the analog data signal from the transmitting circuit and an output providing a synchronous digital data signal;

b) an encoder circuit connected to the output of the analog-to-digital converter for encoding the digital data signal into a selected format;

c) an oscillator circuit connected to the analog-to-digital converter and to the encoder circuit to provide a clock signal thereto;

d) a driver circuit connected to receive the encoded digital signal from the encoder circuit and providing a digital output signal;

e) a first isolation capacitor having an input connected to receive the digital output signal from the driver circuit;

f) a clock recovery circuit having an input connected to an output of the isolation capacitor, the clock recovery circuit providing a clock signal that is substantially synchronized with the clock signal provided by the oscillator circuit;

g) a decoder circuit having a decoder input connected to the isolation capacitor output, a clock input connected to receive a clock signal from the clock recovery circuit, and a digital data output; and

h) a digital-to-analog converter connected to the digital data output, the digital-to-analog converter having an output terminal for providing an isolated analog signal to the receiving circuit.

8. The isolation system of claim 7, wherein the analog-to-digital converter and the digital-to-analog converter comprise delta-sigma modulators.

9. The isolation system of claim 7, further comprising a second isolation capacitor having an input and an output, and wherein the driver circuit is a differential output driver circuit having differential outputs connected to the inputs of each of the first and the second isolation capacitors, and wherein the clock recovery circuit has differential inputs connected to the outputs of each of the first and the second isolation capacitors.

10. The isolation system of claim 7, further comprising an isolated DC power supply circuit having an input connected to the first isolation capacitor and a power supply output connected to the clock recovery circuit and to the decoder circuit, the power supply circuit comprising a rectifier circuit and a filter circuit.

11. The isolation system of claim 7, wherein the encoder circuit comprises a digital control signal input for receiving a digital control signal from the transmitting circuit, and a multiplexer for multiplexing the digital control signal with the digital data signal, and wherein the decoder circuit comprises a demultiplexer for separating the digital control signal from the digital data signal.

12. A method for conveying an analog signal from a transmitting circuit to a receiving circuit while electrically isolating the transmitting circuit from the receiving circuit, comprising:

converting the analog signal to a synchronous digital signal;

transferring the synchronous digital signal across a capacitive isolation barrier to provide an isolated digital signal;

converting the isolated digital signal to an analog output signal.

13. The method of claim 12, further comprising recovering a clock signal on the receiving circuit side of the barrier, and synchronizing the isolated digital signal to the recovered clock signal.

14. The method of claim 12, wherein the converting steps include using delta-sigma modulation.

15. The method of claim 12, further comprising rectifying part of the isolated digital signal on the receiving side of the barrier to provide a DC power supply.

16. A bidirectional isolation barrier for conveying analog data signals between a powered circuit and an isolated circuit while electrically isolating the powered circuit from the isolated circuit, the barrier comprising:

a first isolation capacitor;

a powered-side signal processing system including:

a first synchronous analog-to-digital converter having an input connected to the powered circuit for receiving an analog data signal to be transmitted across the barrier in a first direction, and an output connected to a first side of the isolation capacitor for providing a synchronous digital signal to the isolation capacitor;

a first synchronous digital-to-analog converter having an input connected to said first side of the isolation capacitor for receiving synchronous digital signals therefrom when data signals are transmitted in a second direction from the isolated circuit to the

powered circuit, and having an output connected to the powered circuit for providing analog signals thereto;

an isolated-side signal processing system including:

a second synchronous digital-to-analog converter having an input connected to a second side of the isolation capacitor for receiving a synchronous digital signal therefrom when the data signals are transmitted in said first direction, and having an output connected to the isolated circuit for providing a reconstructed analog data signal thereto; and

a second synchronous analog-to-digital converter having an input connected to the isolated circuit for receiving an analog data signal to be transmitted across the barrier in said second direction to the powered circuit, and an output connected to the second side of the isolation capacitor for conveying a synchronous digital signal corresponding to said analog data signal to the isolation capacitor.

17. The isolation barrier of claim 16, further comprising a second isolation capacitor, and wherein the synchronous digital signal passed across the first and second capacitors is a differential signal.

18. The isolation barrier of claim 16, the isolated-side signal processing system further comprising a power supply circuit having an input connected to the first isolation capacitor to receive the synchronous digital signal, the power supply comprising a rectifier circuit for providing a DC voltage signal.

19. A telephone set comprising the isolation barrier of claim 16.

20. The isolation barrier of claim 16, wherein the synchronous analog-to-digital converters comprise delta-sigma modulators and wherein the synchronous digital-to-analog converters comprise delta-sigma modulators.

21. The isolation barrier of claim 16, further comprising a clock recovery circuit having an input connected to the isolation capacitor for receiving the synchronous digital signal therefrom, the clock recovery circuit having a data output and a clock output, the clock output providing a recovered clock signal, and the data output providing a digital data signal that is synchronized with the recovered clock signal.

22. The isolation barrier of claim 21, wherein the clock recovery circuit comprises a phase locked loop circuit including a filter circuit to reduce jitter in the recovered clock signal.

23. An isolated digital-to-analog converter for converting synchronous digital signals received from an isolation barrier into analog signals, comprising:

a clock recovery circuit having an input connected to the isolation barrier and being adapted to produce a recovered clock signal that is synchronized to the synchronous digital signals, the clock recovery circuit comprising a latch for resynchronizing the synchronous digital signals to the recovered clock signal; and

a synchronous digital-to-analog converter having a clock input connected to receive the recovered clock signal from the clock recovery circuit, a data input connected to receive the resynchronized digital signals from the clock recovery circuit, and an analog output.

24. The isolated digital-to-analog converter of claim 23, wherein the synchronous digital-to-analog converter comprises a delta-sigma modulator.

25. The isolated digital-to-analog converter of claim 23, wherein the clock recovery circuit comprises a phase locked loop and a filter circuit.

26. A method for transmitting an analog data signal across a capacitive isolation barrier, comprising:

converting the analog signal to a digital data signal;

combining the digital data signal with control information to form a digital encoded signal;

driving the digital encoded signal across the capacitive isolation barrier;

receiving an isolated encoded signal from the isolation barrier;

recovering a clock signal from the isolated encoded signal;

synchronizing the isolated encoded signal with the clock signal;

separating the isolated encoded signal into an isolated digital data signal and isolated control information; and

converting the isolated digital data signal into an isolated analog signal.

27. The method of claim 26, wherein the converting steps include using delta-sigma modulation to perform the analog to digital conversion and the digital to analog conversion.

28. An isolation system for providing a digital communication channel between a powered circuit and an isolated circuit, the isolation system comprising an isolation barrier and a clock recovery circuit located on an isolated side of the isolation barrier, the clock recovery circuit adapted to provide a recovered clock signal based on isolated signals received from the powered circuit across the isolation barrier, the recovered clock signal being substantially free of phase noise, the isolation system further comprising an analog to digital converter having an input connected to the powered circuit and an output connected to the isolation barrier, and a digital to analog converter having an input connected to the isolation barrier and an output connected to the isolated circuit.

29. The isolation system of claim 28, wherein the isolation barrier comprises one or more capacitors.

30. The isolation system of claim 28, wherein the digital communication channel is bidirectional.

31. The isolation system of claim 28, wherein the clock recovery circuit comprises a phase-locked loop circuit.

32. The isolation system of claim 31, wherein the phase-locked loop circuit comprises a loop filter circuit for reducing the effects of phase noise on the recovered clock signal.

33. The isolation system of claim 28, wherein the isolated signals are data signals.

34. The isolation system of claim 28, wherein the isolated signals are clock signals.

35. The isolation system of claim 28, wherein the analog to digital converter and the digital to analog converter are delta sigma converters.

36. A bidirectional isolation system for providing an isolated communication channel for data signals in a forward direction and in a reverse direction across an isolation barrier comprised of isolation elements, the system comprising:

a powered system on a first side of the isolation barrier, the powered system comprising a powered analog to digital converter having a data input terminal and an output connected to a first driver circuit, the first driver circuit being connected to the isolation barrier for driving a forward direction digital signal across the isolation barrier; and

an isolated system on a second side of the isolation barrier, the isolated system comprising an isolated analog to digital converter having a data input terminal and an output connected to a second driver circuit, the second driver circuit being connected to the isolation barrier for driving a reverse direction digital signal across the isolation barrier;

wherein the forward direction digital signal and the reverse direction digital signal are both driven through the same isolation elements.

37. The isolation system of claim 36, wherein the isolation elements are capacitors.

38. The isolation system of claim 36, wherein the first and second driver circuits are differential driver circuits.

39. The isolation system of claim 36, wherein the forward direction digital signal comprises said data signal multiplexed with a control signal.

40. The isolation system of claim 36, wherein the forward direction digital signal comprises said data signal multiplexed with a control signal.

41. The isolation system of claim 36, wherein the analog to digital converters are delta sigma converters.

42. An isolation system for providing a digital communication channel for data signals and control signals, the isolation system comprising:

an isolation barrier;

an analog to digital converter connected to receive the data signals having an output for providing digitized data signals;

a multiplexer located on one side of the isolation barrier and connected to receive the digitized data signals and the control signals and providing a multiplexed digital signal that is connected to the isolation barrier;

a demultiplexer located on the other side of the isolation barrier and connected to receive the multiplexed digital signal from the isolation barrier, the demultiplexer having a digitized data signal output and a control signal output; and

a digital to analog converter having an input connected to the digitized data signal output and an analog output terminal.

43. The system of claim 42, wherein the isolation barrier is a capacitive isolation barrier.

44. The system of claim 42, wherein the multiplexed digital signal is conveyed across the isolation barrier as a differential digital signal.

45. The isolation system of claim 42, wherein the analog to digital converter and the digital to analog converter are delta sigma converters.